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NATIONAL AIRSPACE SYSTEM

FAA's Approach to Its New Communications System Appears Prudent, but Challenges Remain



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Abbreviations

ACARS	Aircraft Communications Addressing and Reporting System
FAA	Federal Aviation Administration
GHz	gigahertz
ICAO	International Civil Aviation Organization
kHz	kilohertz
MHz	megahertz
NARC	NEXCOM Aviation Rulemaking Committee
NASA	National Aeronautics and Space Administration
NEXCOM	Next Generation Air/Ground Communications
VHF	very high frequency
VDL-2	Very High Frequency Digital Link Mode 2
VDL-3	Very High Frequency Digital Link Mode 3
VDL-4	Very High Frequency Digital Link Mode 4



**United States General Accounting Office
Washington, DC 20548**

July 15, 2002

The Honorable John L. Mica
Chairman
The Honorable William O. Lipinski
Ranking Democratic Member
Subcommittee on Aviation
Committee on Transportation and
Infrastructure
House of Representatives

The Federal Aviation Administration (FAA) uses radios to provide air-ground voice and data communications for pilots and air traffic controllers to safely coordinate all flight operations—ground movements of aircraft at airports, take-offs and landings, and separation distances between aircraft as they cruise at high altitudes. However, the anticipated growth in air traffic, coupled with FAA's efforts to reduce air traffic delays and introduce new air traffic services, will create a demand for additional channels for voice communications that FAA's current system cannot provide. FAA is implementing a new communications system to respond to this challenge and also seeking to enhance its existing ability to transmit data to provide more information to pilots, reduce errors in voice communications, and better balance controllers' workload. Moreover, FAA expects that its new system should be less susceptible to interference from such sources as power lines and radio and television stations and also improve security against unauthorized users. FAA is developing products to use with its future integrated voice and data communications system. FAA refers to the initiative to acquire this system as Next Generation Air/Ground Communications (NEXCOM) and estimates that its long-term funding commitment for this initiative could reach \$4 billion through fiscal year 2023.

Because voice and data communications are critical to air traffic management, you asked us to determine (1) to what extent the existing voice and data communications system used by FAA can effectively meet its expected future needs, (2) what FAA has done to help ensure that the technology it wants to use for NEXCOM will meet its future needs, and (3) what major issues FAA needs to resolve before it can make a final decision on the technology it wants to use for NEXCOM. To address these objectives, among other things, we interviewed and analyzed data and documentation from FAA program officials, experts in communications from the Department of Defense and the National Aeronautics and Space

Administration, representatives of national and international aviation groups, and officials representing FAA's controller and maintenance workforces. We did not verify the data FAA provided or the results of FAA's analysis.

Results in Brief

FAA and the aviation industry agree that the existing communications system, even with enhancements, cannot meet aviation's expanding need for communications. FAA has identified 23 measures to improve its existing voice communications system, which the agency and industry believe will add several years to its useful life. However, they believe that it will not meet aviation's future voice communications needs beyond 2009, even with these improvements. Because FAA's current system does not provide the capability for data link communications, the agency is currently leasing this service from a commercial vendor. However, even with planned improvements to this leased service, it will not meet FAA's projected needs for sharing data between FAA facilities and with aircraft operators. As FAA relies more on data communications, in part to help alleviate voice congestion, this service cannot meet the need to prioritize those messages that must be delivered expeditiously.

To help ensure that the technology it wants to use for NEXCOM will meet its future needs, FAA completed a comparative analysis of numerous technologies, in collaboration with the aviation industry, to assess each one's ability to meet technical requirements, minimize program risk, and meet the agency's schedule. As a result of this analysis, in March 1998, FAA selected Very High Frequency Digital Link Mode 3 (VDL-3) as the technology it wanted to use for its future communications needs. Although five other technologies, such as FAA's current voice communications system coupled with a commercially available data link communications system, offered some potential to satisfy a broad range of future needs, each was rejected during the evaluation process. FAA plans to implement its preferred technology for NEXCOM by using a phased approach to help ensure that this technology can continue to meet its future needs. In September 2001, an aviation industry panel conditionally approved FAA's preferred technology.

However, before making a final decision to select the technology for NEXCOM, FAA will need to effectively address three major issues: whether the preferred technology is technically sound and will operate as intended, if the preferred technology and the equipment it requires can be certified as safe for use in the National Airspace System, and whether it is cost effective for users and the agency. To evaluate the technical and

operational merits of the technology it wants to use, FAA has scheduled a series of three system demonstrations to be completed between October 2002 and October 2004. Using the preferred technology, these tests will, among other things, demonstrate the integration of voice and data communications and that the new equipment required for NEXCOM is compatible with existing equipment. Moreover, these tests will also demonstrate if this integrated system can be certified as safe for aircraft operations. Because FAA plans to require aviation users to buy new radios and other equipment to use with the technology it selects for NEXCOM, FAA has begun to analyze the cost and benefits of the technology it wants to use. Under FAA's current plans, the agency is assuming a 30-year useful life for the NEXCOM technology it wants to use. However, emerging technologies might shorten the useful life and thus reduce the overall benefits. To help ensure that FAA's final selection for NEXCOM is the most cost effective for the agency and aviation users, we are recommending that, as part of its cost benefit analysis before committing to a technology, FAA assess the potential impact of emerging technologies in light of its requirements.

In commenting on a draft of this report, the Product Team Lead for Air/Ground Voice Communications and officials from Spectrum Policy and Management, FAA, indicated that they generally agreed with the facts and recommendation. These officials and those from the National Aeronautics and Space Administration provided a number of clarifying comments, which we have incorporated where appropriate.

Background

Air traffic controllers monitor and direct traffic in a designated volume of airspace called a sector. Each sector requires a separate channel assignment for controllers to communicate with aircraft flying in that sector. As the amount of air traffic grows, the need for additional sectors and channel assignments also increases. FAA's present air-ground communications system operates in a worldwide, very high frequency (VHF) band reserved for safety communications within the 118 to 137

megahertz (MHz) range.¹ Within this range of frequencies, FAA currently has 524 channels available for air traffic services. During the past four decades, FAA has primarily been able to meet the increased need for more channel capacity within this band by periodically reducing the space between channels (a process known as channel splitting). For example, in 1966, reducing the space between channels from 100 kHz to 50 kHz doubled the number of channels. The last channel split in 1977, from 50 kHz to 25 kHz, again doubled the number of channels available. Each time FAA reduced this space, owners of aircraft needed to purchase new radios to receive the benefits of the increased number of channels. FAA can use or assign its 524 channels several times around the country (as long as channel assignments are separated geographically to preclude frequency interference). Through channel reuse, FAA can make up to 14,000 channel assignments nationwide. While aviation literature often refers to channel and channel assignments as frequency and frequency assignments, throughout this report, we use the terms channel and channel assignments.

Because the growth in air traffic during the past decade has created a need for more communications channels since the 1977 split, FAA has been increasingly concerned that the demand for channels would exceed their availability, which would cause frequency congestion. FAA first explored this issue at length at a 1990 International Civil Aviation Organization (ICAO) conference,² at which the ICAO member countries addressed increasing congestion in the air traffic control communications band and the especially acute problem in the U. S. and Western Europe. Over the next 5 years, ICAO evaluated different solutions that were proposed by the conference's participants. While the Western European countries proposed further channel splitting to increase capacity, FAA proposed a totally new air-ground communications system. FAA's proposed technology, known as VDL-3, would be based on a new integrated digital

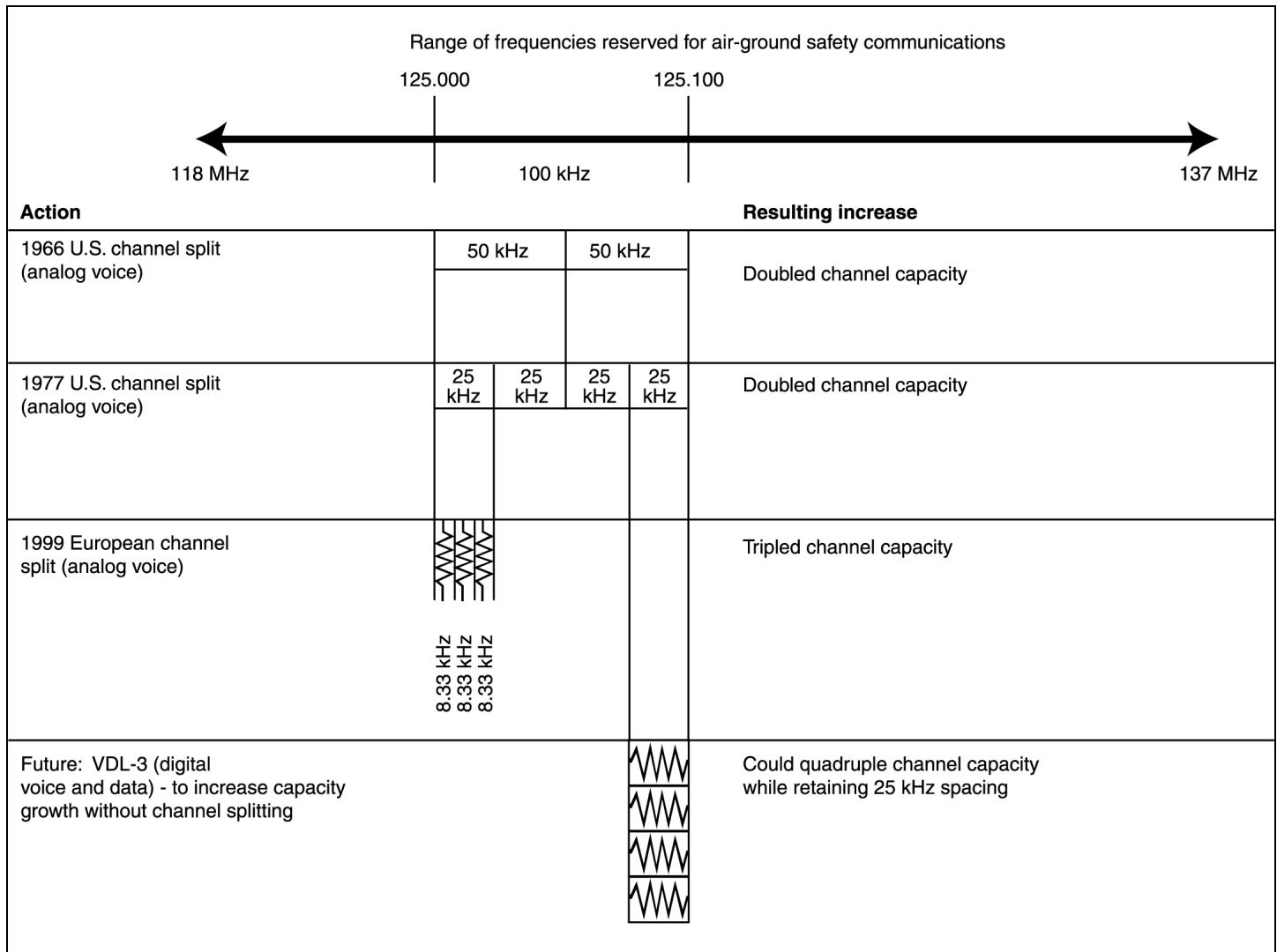
¹Frequency is the number of waves traveling by a given point per unit of time, in cycles per second, or hertz. Radio frequency is usually measured in thousands of hertz or kilohertz (kHz), millions of hertz or megahertz (MHz), and billions of hertz or gigahertz (GHz). Because the range of consecutive frequencies makes up a band, the greater the range of frequencies, the greater the bandwidth. In addition to using this bandwidth for air traffic services, FAA uses it for such other services as flight-testing and air shows. Other organizations, such as the Department of Defense and commercial airlines, also use it for flight-testing and airline operations.

²ICAO is a specialized agency of the United Nations that sets international standards and regulations necessary for the safety, security, and efficiency in all fields of civil aviation.

voice and data communications technology, which would assign segments of a channel to users in milliseconds of time, thereby allowing both voice and data to travel over the same channels using one of the available time slots. Under the current system, each channel is used exclusively and continuously for voice, so the air traffic controller can communicate at all times with the aircraft. This new technology could provide up to a fourfold increase in capacity without channel splitting, thus meeting the demand for new voice channels. VDL-3 digitizes a person's voice and sends it as encoded bits of information, which is reassembled by the receiver. Moreover, this technology could provide real-time data link on-board communications of air traffic control messages and events.

Although ICAO adopted FAA's proposed digital air-ground communications system VDL-3 in 1995 as its model for worldwide implementation, it also approved standards allowing Western Europe, which was then experiencing severe frequency congestion, to further reduce the spacing between channels from 25 kHz to 8.33 kHz. While this action tripled the number of channels available for assignment, it also resulted in the need for aircraft flying in Western Europe to install new radios that are capable of communicating over the 8.33 kHz channels. ICAO intended that this reduction would be an interim measure until 2004, when FAA estimated that the technology it had proposed would be operational. However, FAA did not pursue developing VDL-3 in 1995, in part, because its existing communications system still had available capacity to meet near-term communications needs, and because the agency's need to modernize its air traffic control system became an urgent priority. In 1998, FAA resumed developing VDL-3; however, the agency is not expected to implement this technology until 2009. Figure 1 depicts how channel splitting has increased channel capacity since 1966 and how FAA's proposed use of VDL-3 will further increase channel capacity.

Figure 1: Increasing Channel Capacity through Channel Splitting, 1966 through 1999, and the Proposed Future Use of VDL-3



Source: GAO's presentation of information provided by FAA.

FAA's Planned Improvements Would Likely Expand the Life of Its Existing Communications System but Would Not Meet Aviation Needs Beyond 2009

FAA has identified 23 measures to improve its existing voice communications system. While FAA and the U. S. aviation industry generally believe that implementing all these measures would add several years to the useful life of the existing system, they believe it would not meet aviation's future voice communications needs beyond 2009. Because increases in air traffic create the need for more channel assignments, the events of September 11, which have resulted in slower than expected increases, might delay by a year or two when FAA starts to encounter problems systemwide in providing new channel assignments. Agency and industry representatives agree that it is not possible to precisely predict when the existing system with its planned improvements will no longer meet aviation's needs. As a result, FAA plans to annually assess whether this system will be capable of meeting the projected need for more channel assignments for at least 5 years into the future. FAA plans to release the first of these annual assessments in September 2002.

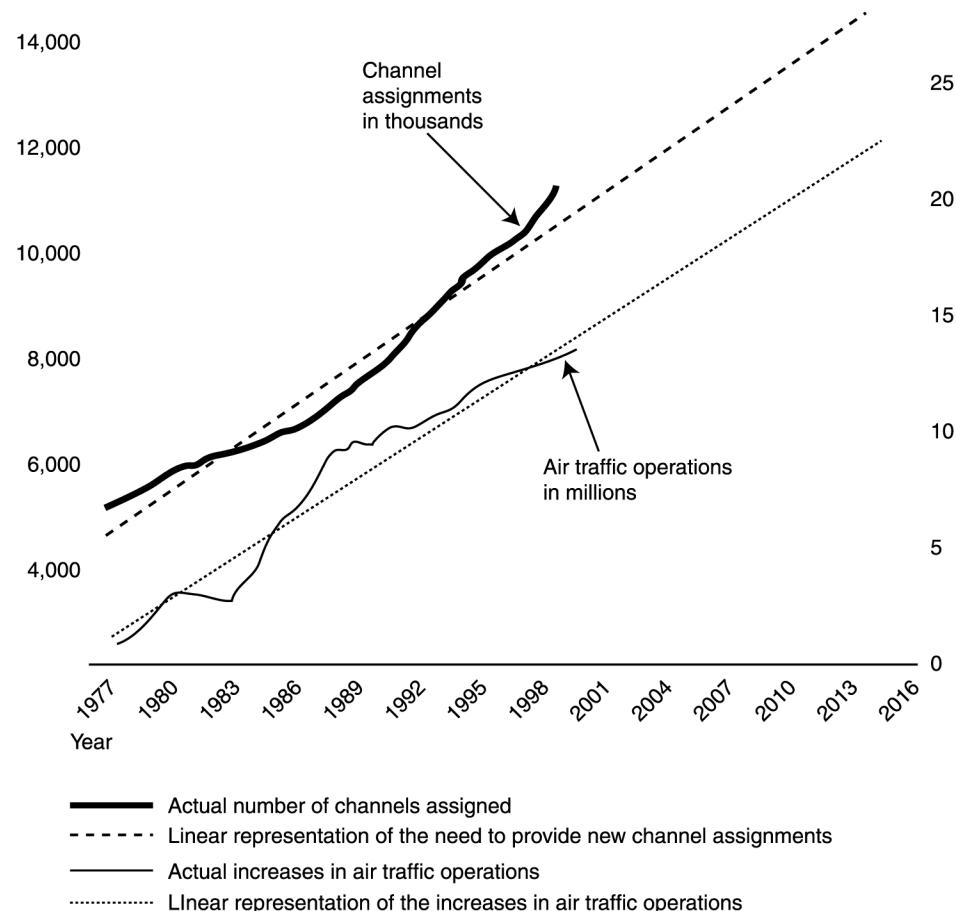
While the focus of FAA's efforts has been to meet aviation's need for voice communications through 2009, FAA recognizes that its data communications needs are evolving. The agency expects to increase its use of data communications to help alleviate voice congestion and to help controllers and pilots accurately exchange more information. Because FAA's current system cannot do this, it has been leasing data link services from ARINC.³ However, even with the planned improvements, this service will not be able to meet FAA's projected need for more data communications. As FAA relies more on data communications, this leased system will not be able to meet the agency's need to prioritize those messages that must be delivered expeditiously. Recognizing that accurately projecting the growth in aviation's need for data link communications beyond 15 years would be difficult, FAA is designing a system to provide a sevenfold increase in capacity to meet future needs.

³ARINC coordinates radio frequencies for the airlines and is a leader in providing air-ground communications worldwide.

FAA Does Not Have Enough Channels to Meet Aviation's Projected Need for Voice Communications

During the 1990s, several of FAA's studies found that, historically, increases in air traffic were closely related to the growing need to assign more channels for voice communications (see fig. 2).

Figure 2: Relationship between the Demand for Assigning Channels for Voice Communications and Increases in Air Traffic, 1977 through 2016



Source: GAO's presentation of FAA's data.

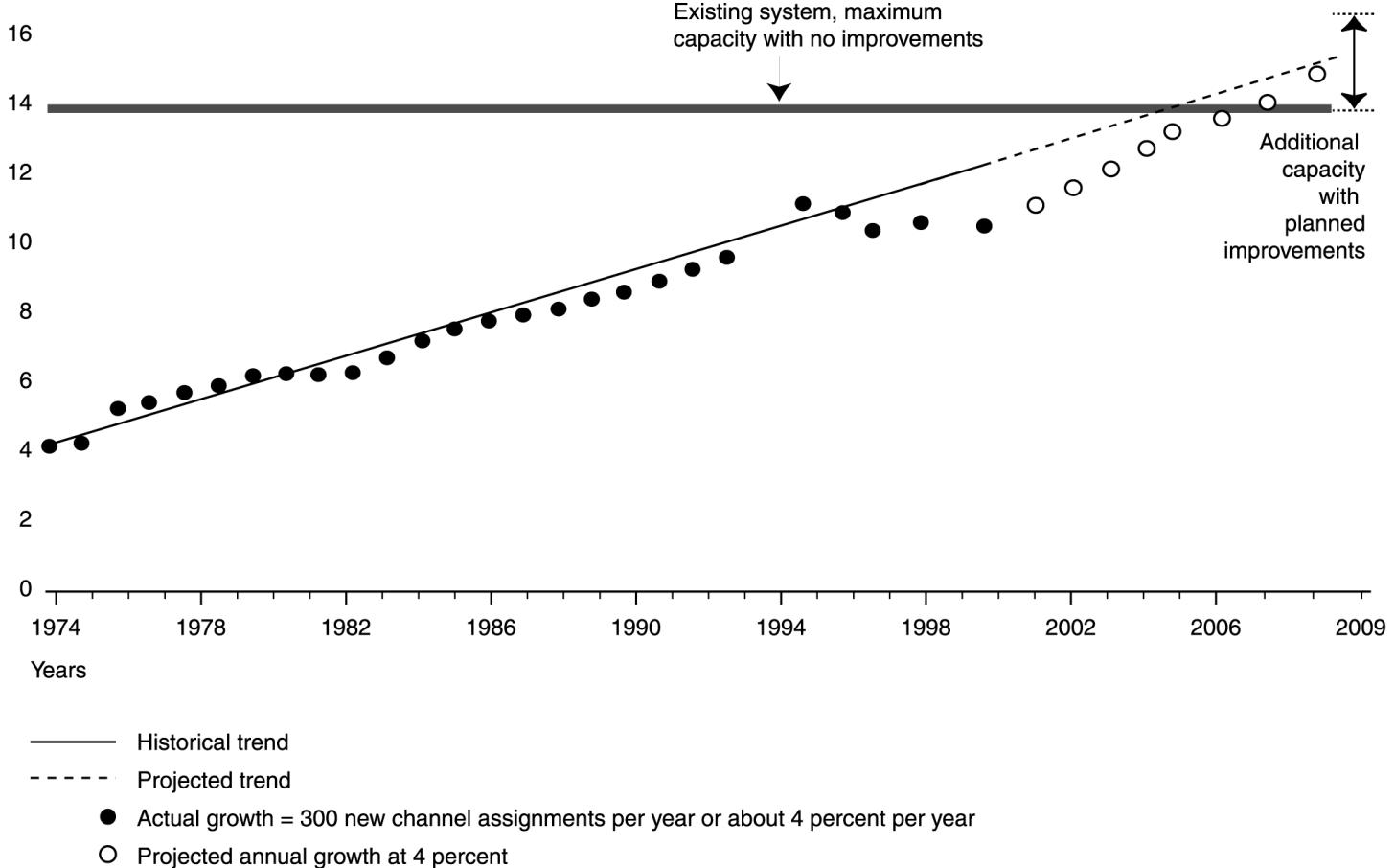
In its most recent study about the growing need for more channel assignments for voice communications,⁴ FAA found that this need had grown annually, on average, about 4 percent (about 300 new channel assignments) since 1974 (see fig. 3). This growth paralleled the increase in domestic air travel during that time frame. Despite the recent downturn in air traffic resulting from a recession and the September 11 terrorist attacks, FAA expects it to resume its historical 4-percent annual growth within a year or two. Currently, FAA's voice communications system is limited to a maximum of 14,000 channel assignments. Because increases in air traffic require more new channel assignments, FAA expects that providing them in some metropolitan areas will become increasingly difficult. If the system is left unchanged, FAA has concluded that, as early as 2005, it could no longer fully support aviation's need for voice communications and that in such high traffic metropolitan areas as New York, Chicago, and Los Angeles the need for additional assignments could be evident sooner.

⁴FAA's *Radio Spectrum Plan for 2001–2010*, which was issued on September 30, 2001, does not reflect the impact of the terrorist attacks of September 11.

Figure 3: FAA's Channel Assignments for Voice Communications, Actual, and Projected, 1974 through 2009

Channel assignments in thousands

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Because FAA has delayed NEXCOM's implementation until 2009, the agency's 23 planned improvement measures are designed to add approximately 2,600 additional channel assignments for voice communications. (See table 1.) FAA has classified these initiatives, which involve a variety of technical, regulatory, and administrative changes, according to how soon it expects to implement them. However, FAA recognizes that there is no guarantee that all of these measures can be implemented because some of them largely depend on gaining agreement from other entities, such as other federal agencies and the aviation

community, and some may involve international coordination. FAA also recognizes that the exact degree of improvement resulting from the totality of these measures cannot be precisely projected and actual test results could show less gain than anticipated. Many of these initiatives involve reallocating channels being used for purposes other than air traffic services and increasing FAA's flexibility to use already assigned channels. For example, FAA is reviewing its policy for assigning channels to such special events as air shows to determine if fewer channels could be assigned to them so that channels could be used for other purposes.

Table 1: FAA's Plans Provide for Additional Channel Assignments for Voice Communications

Year	Improvement measures	Additional channel assignments
2003	15	1,041
2005	7	1,574
2009	1	^a
Total	23	2,615

^aFAA is still studying the gains that this measure should achieve.

Source: GAO's analysis of FAA's data.

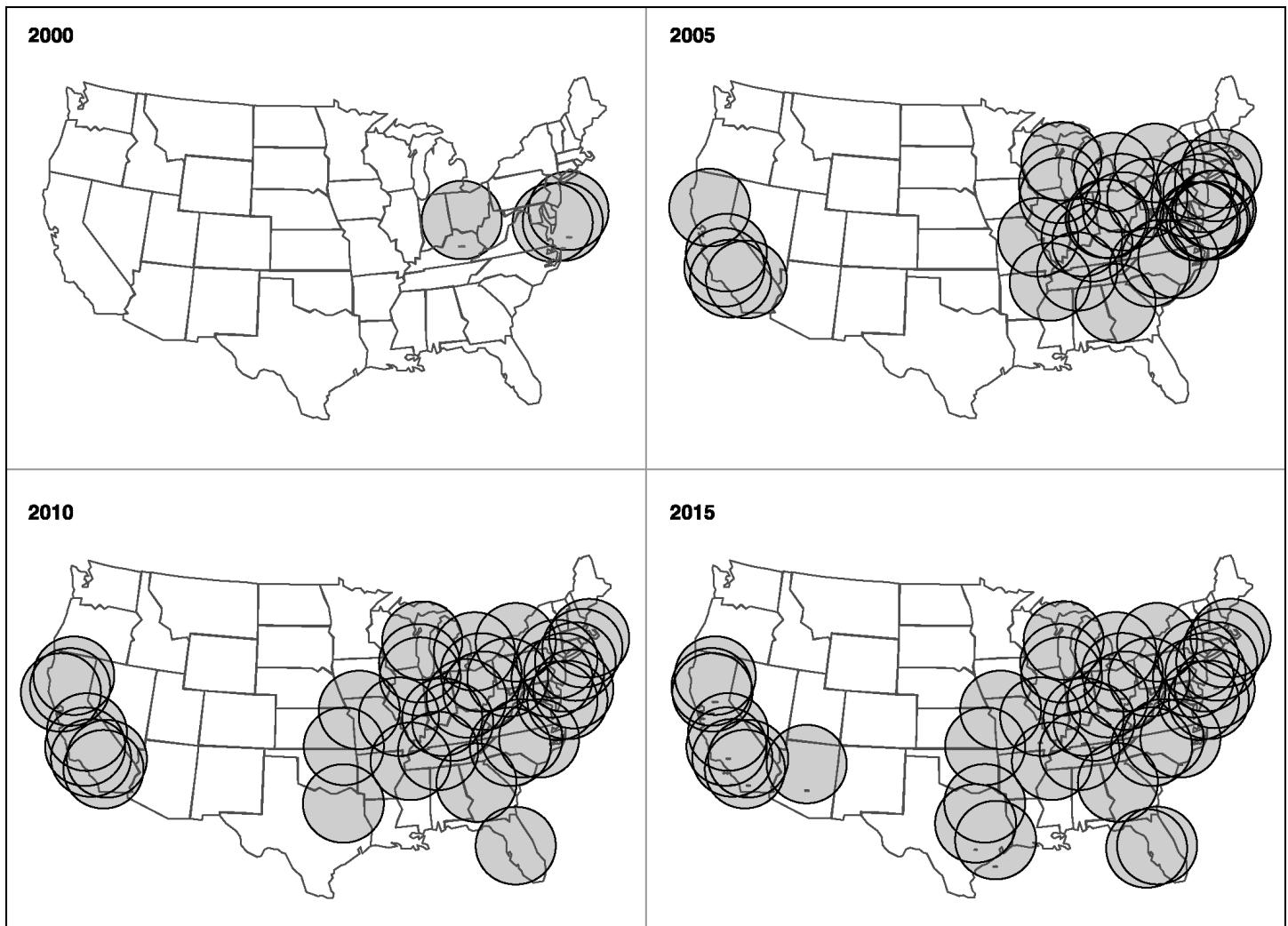
While it is not possible to predict exactly when FAA's existing voice communications system will run out of available channel assignments, agency and aviation representatives concur that, without the 23 improvement measures, the system will be strained to provide enough channel assignments. According to a MITRE Corporation study completed in 2000,⁵ even if the need for more channel assignments for voice communications were to grow at 2 percent per year (instead of FAA's projected growth of 4 percent per year), by 2005 or sooner, it would be difficult for FAA to meet the need for air traffic communications in major metropolitan areas. MITRE also projected that the shortage of available channel assignments would become a nationwide problem by 2015 or sooner.⁶ In 2000, FAA first encountered a shortage problem when it had to reassign a channel from one location to another that FAA viewed as a higher priority in the Cleveland area. Figure 4 shows MITRE's analysis of

⁵MITRE provides air traffic control, air traffic management, and airport systems engineering support to FAA and civil aviation authorities around the world.

⁶Due, in part, to the events of September 11, 2001, concerns also exist about the adequacy of radio spectrum resources to enable public safety agencies to communicate with one another.

how the projected demand for more voice communications capacity will intensify if FAA does nothing to improve this system.

Figure 4: Effect of a Projected 2-Percent Annual Increase in Air Traffic on FAA's Ability to Make New Channel Assignments for Voice Communications, 2000 through 2015



Note: Each circle represents where the demand for voice communications capacity will inhibit FAA's ability to meet new air traffic needs.

Source: GAO's presentation of MITRE's analysis.

FAA Does Not Have Enough Channels to Meet Aviation's Projected Need for Data Communications

Currently, FAA is leasing ARINC's Aircraft Communications Addressing and Reporting System (ACARS) to provide data link communications that are not time critical, such as forwarding clearances to pilots prior to takeoff.⁷ Because this analog system is also reaching its capacity to handle data link communications, FAA plans to use ARINC's new digital data communications system, known as Very High Frequency Digital Link Mode 2 (VDL-2) until 2009.⁸ By then, FAA expects to use its VDL-3 system, which is being developed to integrate voice and data communications, to meet aviation's needs for about 1,800 channel assignments for data communications over the next 15 years and to prioritize messages that must be delivered expeditiously, which VDL-2 cannot provide. Because FAA believes that aviation's need for data communications cannot be realistically projected beyond 15 years, it is designing a system to provide a sevenfold increase in capacity for data communications, thereby providing what it believes is an excess capacity that should meet aviation's future needs.

To Help Ensure NEXCOM Will Meet Future Communications Needs, FAA Has Collaborated with the Aviation Industry to Assess Alternative Technologies

In consultation with stakeholders from the aviation industry, FAA selected VDL-3 as the preferred solution to meet its future communications needs. During the 1990s, FAA collaborated with its stakeholders to analyze many different communications systems, as well as variations of them, as potential candidates to replace its existing communications system. As a result of these studies, FAA eliminated several designs because they did not meet some of the fundamental needs established for NEXCOM. For example, FAA found that Europe's Very High Frequency Digital Link Mode 4 (VDL-4) technology was too early in development to assess and that it would not provide voice communications, FAA's most pressing need. Moreover, a vendor of VDL-4 recently told us that this technology still needed additional development to meet FAA's communications needs and that the international community had not yet validated it as a standard for air traffic control communications, which could take at least an additional 3 years. In March 1998, FAA rated VDL-3 as the best of the six possible

⁷ACARS is an analog data link communications system designed primarily for airlines' use.

⁸Analog radios rely on signals that use electric currents with continuously variable voltages to reproduce data being transmitted. Because an analog system transmits data by using variable voltages, removing noise and wave distortions is very difficult. For this reason, analog signals cannot perform high-quality data transmission. Because digital radios rely on signals that use binary digits (0 and 1) to transmit data, there is little interference. The resulting high-quality transmission of data at high speeds is crucial for communications that use computers because they use digital signals to process information.

technologies to meet its future communications needs and the most likely to meet its schedule with the least risk. FAA found that VDL-3, the international model for aviation communications, could

- provide up to a maximum fourfold increase in channel capacity, but the increase is estimated to be three to fourfold because of initial deployment scenarios;
- transmit voice and data communications without interference;
- increase the level of security;
- provide voice and data communications to all users with minimal equipment replacement;
- require no additional channel splitting, thereby reducing the need for engineering changes; and
- reduce the number of ground radios required by FAA because each radio could accommodate up to four channels within the existing 25 kHz channel spacing.

Although FAA and its stakeholders thought that each of the five other technologies had some potential to satisfy a broad range of their future needs, each was rejected during the 1998 evaluation process. (See table 2.)

Table 2: Alternative Technologies and Reasons for Their Rejection

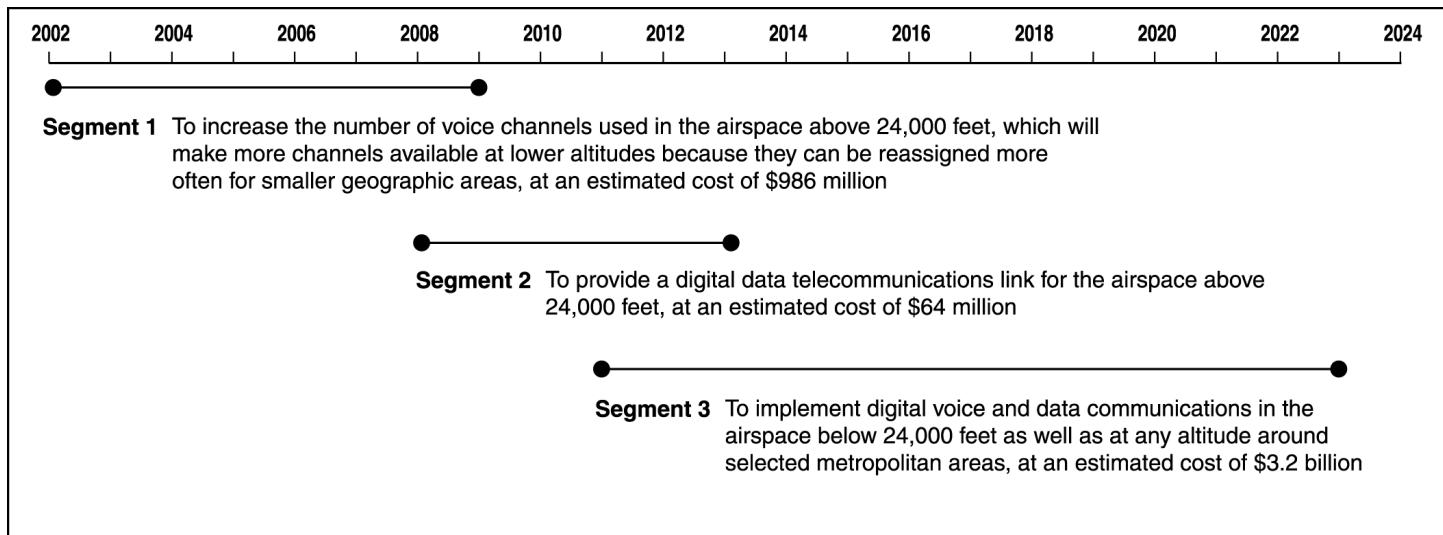
Alternative	Description	Reason for rejection
25 kHz and VDL-2	FAA's current analog voice communications technology and a separate digital data technology that ARINC is developing for aviation	Would not provide the needed additional channels for voice communications because the channels would need to be reassigned to communicate data
8.33 kHz and VDL-2	A system providing additional channel capacity by reducing the space between channels by using FAA's current analog voice communications technology and a separate digital data technology that ARINC is developing for aviation	—Could only double the number of voice channels —Could not resolve existing radio interference and loss of communications issues and —Would likely require a significant increase in the number of ground radios
Cellular telecommunications	A commercially available digital technology that would need to be enhanced for air traffic control	Significant technical challenges would preclude meeting FAA's need to deploy an initial operational system by 2005
Geostationary satellites	A system whose satellites maintain fixed positions at 22,000 miles above the earth	Significant technical challenges would preclude meeting FAA's need to deploy an initial operational system by 2005
Low-earth orbit or medium-earth orbit satellites	A system whose satellites can range from 200 to 500 miles above the earth or a system from a few hundred to a few thousand miles above the earth	Significant technical challenges would preclude meeting FAA's need to deploy an initial operational system by 2005

Source: GAO's presentation of FAA's data.

Academia and other experts have concluded that FAA's rationale for rejecting alternative technologies in 1998 remains valid today. Specifically, the technical challenges facing these technologies have not been sufficiently resolved to allow FAA to deploy an initial operating system by 2005. For example, while satellite technology is used to provide voice and data communications across the oceans and in remote regions, it is expensive, it does not support the need for direct aircraft-to-aircraft communications, and does not meet international standards for air traffic control communications. Representatives from the National Aeronautics and Space Administration (NASA) told us that emerging technologies that could meet FAA's need for voice and data communications could be developed and available by 2015. However, in further discussion with these representatives, they indicated that while such technologies might be mature enough to provide communications services, it may require additional time for them to meet all of the requirements associated with air traffic control safety systems. NASA officials commented that FAA initiated its plans for its new communications system at the outset of the emerging wireless technology explosion and was not able to assess and integrate any of these emerging technologies into the NEXCOM architecture. However, they noted that the telecommunications field is changing rapidly, and FAA and the aviation industry will need to continually assess their requirements and keep abreast of emerging technologies that could better meet their future communications needs.

FAA's planned approach for NEXCOM is to implement VDL-3 in three segments, as shown in figure 5. Currently, FAA's senior management has only approved investments for the first segment.

Figure 5: FAA's Planned Approach to Implement VDL-3



Note: In segment 1, FAA plans to start deploying radios that can operate in both the current analog and future digital modes because voice communications will continue in the analog mode until 2009 when FAA plans to start providing digital voice communications.

Source: GAO's presentation of FAA's plans.

If FAA cannot demonstrate that VDL-3 can successfully integrate both voice and data in a cost-effective manner, FAA plans to implement a backup approach to meet the need for more channel capacity. FAA's backup follows the Western European approach as follows:

- For analog voice communications, reduce the 25 kHz space between channels to 8.33 kHz.
- For digital data communications, rely on a commercial vendor that is developing a technology to support aviation's need for data, known as VDL-2.

However, this approach remains a backup because it doubles, not quadruples, voice channel capacity. Furthermore, it does not resolve the issues of radio interference and loss of communications that now confront FAA, nor does it meet all of the requirements for air traffic control data link communications.

FAA Needs to Resolve Three Key Issues Before It Can Make a Final Decision on the Technology for NEXCOM

Before selecting VDL-3 as the technology for NEXCOM, FAA needs to demonstrate the technical and operational merits of VDL-3, certify VDL-3 as a “safety critical system,” and prove its cost-effectiveness to the aviation industry. To help address these issues, the FAA Administrator formed the NEXCOM Aviation Rulemaking Committee (NARC) in 2000.⁹ The NARC, composed of representatives from the aviation industry and other groups, submitted its final report in September 2001, which included recommendations to expedite the resolution of technical and operational issues involving NEXCOM.

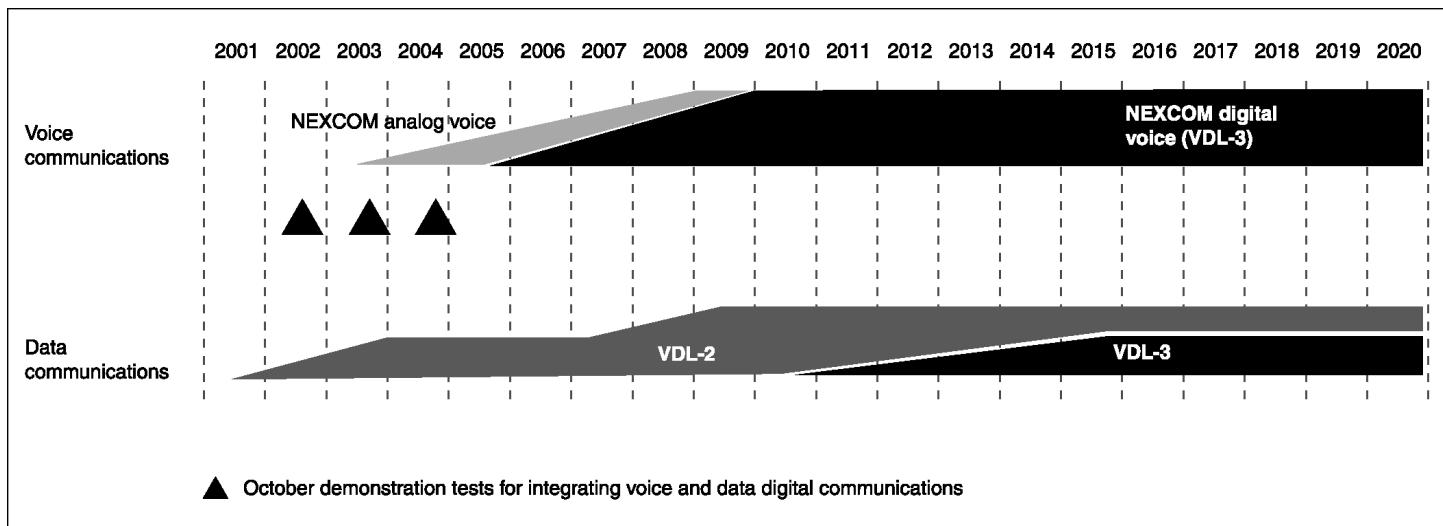
To demonstrate VDL-3’s technical and operational merits, FAA has scheduled a series of three tests of this technology, beginning in October 2002 and ending in October 2004. The first test is designed to demonstrate the quality of voice communications and the integration of voice and data communications. A key component of the second test is to demonstrate that new digital ground radios can work with new digital aircraft equipment and other equipment in FAA’s air traffic control system.¹⁰ Finally, in the third test, FAA plans to validate that VDL-3 can be certified as safe for aircraft operations. Moreover, to make VDL-3 fully operational will require FAA and users to undertake a phased installation of tens of thousands of new pieces of equipment. In addition to FAA and users installing radios with new transmitters and receivers, FAA would need to install new voice switches and workstations. FAA also needs to ensure that all the new equipment required for NEXCOM will be compatible with FAA’s existing equipment, especially the numerous types of voice switches as well as the local and wide area networks. Therefore, FAA estimates that it will take 5 years following the successful conclusion of its demonstration tests for it to install the new ground equipment, while the

⁹The NARC was composed of representatives from various organizations, including the National Business Aviation Association; American, Southwest, Northwest, and United Airlines; the Airline Pilots Association; the Aircraft Owners and Pilots Association; the Department of Defense; the National Air Traffic Controllers Association; Professional Airways Systems Specialists; MITRE; the General Aviation Manufacturers Association; and the Air Transport Association. FAA chartered the NARC to review its previous work on cost, benefits, and transition assumptions and to recommend appropriate actions. Moreover, since some members of the U.S. aviation community knew that Western Europe had chosen a different technology to meet its more pressing need for additional channels for voice communications, they requested that the NARC review both the U. S. and European systems.

¹⁰In July 2001, FAA awarded a contract for ground radios that can operate in either the current analog mode or the future digital mode. Likewise the radios being developed for aircraft will operate in both modes, which will make them compatible with radios being used by the Western European communications system.

airlines install new aircraft equipment. Figure 6 shows FAA's schedule to implement both voice and data digital communications.

Figure 6: FAA's Schedule to Implement Voice and Data Digital Communications



Note: FAA has yet to determine what services it will receive on VDL-2 after it implements VDL-3.

Source: FAA.

Because communications are critical to ensuring safe aircraft operations, FAA is developing a process to certify that VDL-3 and the new equipment it requires could be used in the National Airspace System. In April 2002, FAA's teams responsible for developing and certifying VDL-3 drafted a memorandum of understanding that describes their respective responsibilities. They agreed to maintain effective communications among them as well as with the manufacturers developing VDL-3 equipment. (See table 3 for the schedule for certifying the radios that will be used with VDL-3.) To FAA's credit, the agency is proactively seeking certification before making a final decision on VDL-3.

Table 3: Major Milestones for Certifying VDL-3's Radio Equipment

Date	Milestone
September 2002	Sign a final memorandum of understanding.
August 2003	Publish guidelines for manufacturing FAA-approved digital radios.
August 2004	Certify that the radios selected for NEXCOM meet aviation's needs before the final October 2004 demonstration.

Source: GAO's presentation of information provided by FAA.

The issue of cost effectiveness was raised by the NARC because it wanted FAA to fully analyze the airlines' transition to digital radios before the agency requires their use. Convincing enough users to purchase VDL-3 radios might be difficult because some air carriers had recently bought 8.33 kHz radios for operation in Europe, and they would not be eager to purchase additional equipment. As part of its cost-benefit analysis, FAA is assuming a 30-year life cycle for NEXCOM; however, changing requirements coupled with the rapidly changing developments in telecommunications technology could reduce this life cycle. Without analyzing the costs and benefits under different confidence levels for other potential life cycles for NEXCOM while considering the impact of changing requirements and the effects of emerging technologies, FAA might find it more difficult to enlist the continued support of the aviation community for NEXCOM. FAA plans to begin analyzing the cost-effectiveness of NEXCOM in mid-2002, publish a notice of proposed rulemaking by January 2004, complete its cost-benefit analysis by mid-2004, and publish its final rulemaking by June 2005. FAA officials agreed that it is important to continually evaluate the requirements of the future system and whether emerging technologies could reduce VDL-3's cost-effectiveness prior to making the final selection. Throughout its rulemaking process, program officials stressed that they plan to continue involving all key FAA organizations and the aviation industry.

Conclusions

FAA's approach for selecting its NEXCOM technology appears prudent. The FAA officials managing NEXCOM have worked with the aviation industry and involved other key FAA organizations to help ensure that the technical and operational, safety, and cost-effectiveness issues are resolved in a timely manner. However, FAA is only in the early stages of resolving these three issues, and the program's continued success hinges on FAA's maintaining close collaboration with major stakeholders. FAA's follow-through on the development of a comprehensive cost-benefit analysis, which considers how changing requirements and emerging

technologies could affect the cost effectiveness of VDL-3, will be key to this success. Otherwise, the aviation community might not continue to support FAA in developing NEXCOM, as they now do.

Recommendation

To make the most informed decision in selecting the technology for NEXCOM and continue to receive the support from the aviation community, we recommend that the Secretary of Transportation direct the FAA Administrator to assess whether the requirements for voice and data communications have changed and the potential impact of emerging technologies on VDL-3's useful life as part of its cost-effectiveness analysis of NEXCOM.

Agency Comments

We provided the Department of Transportation, the Department of Defense, and the National Aeronautics and Space Administration with a draft of this report for review and comment. The Department of Defense provided no comments. The Product Team Lead for Air/Ground Voice Communications and officials from Spectrum Policy and Management, FAA, indicated that they generally agreed with the facts and recommendation. These officials, along with those from the National Aeronautics and Space Administration, provided a number of clarifying comments, which we have incorporated where appropriate.

Scope and Methodology

To determine the extent to which FAA's existing communications system can effectively meet its future needs, we interviewed officials from FAA's NEXCOM program office, the agency's spectrum management office, union officials representing the air traffic controller and maintenance technician workforces, representatives of the MITRE Corporation, and members of the NARC, an advisory committee formed by FAA to help ensure that NEXCOM meets the aviation industry's needs. We reviewed documentation on the current status of FAA's existing air-ground communications system as well as documentation on potential measures FAA plans to take to increase the channel capacity of its existing system.

To determine what FAA did to help ensure that its preferred technology for NEXCOM will meet aviation's future needs, we interviewed officials from FAA's NEXCOM program office; officials from the Department of Defense, the National Aeronautics and Space Administration, and

Eurocontrol;¹¹ an expert in satellite communications from the University of Maryland; and contractors who offer VDL-2 and VDL-4 communications services. We reviewed documentation indicating to what extent varying technologies could meet FAA's time frames for implementing NEXCOM. We also reviewed documentation indicating how well varying technologies could meet FAA's specifications for NEXCOM. We did not perform an independent verification of the capabilities of these technologies. Additionally, we reviewed studies performed by FAA in collaboration with the U.S. aviation industry to assess alternative technologies for NEXCOM that led the U.S. aviation community to endorse FAA's decision to select VDL-3 as its preferred technology for NEXCOM.

To identify issues FAA needs to resolve before it can make a final selection for NEXCOM's technology, we interviewed officials from FAA's NEXCOM program office as well as members of the NARC. We also reviewed NEXCOM program office documentation that prioritizes the program's risks, assesses their potential impact on the program's cost and schedule, and describes the status of FAA's efforts to mitigate those risks. In addition, we reviewed the NARC's September 2001 report that made recommendations to FAA for modernizing its air-ground communications system. We conducted our review from September 2001 through May 2002, in accordance with generally accepted government auditing standards.

We are sending copies of this report to interested Members of Congress; the Secretary of Transportation; the Secretary of Defense; the Administrator, National Aeronautics and Space Administration, and the Administrator, FAA. We will also make copies available to others upon request. In addition, the report will be available at no charge on the GAO Web site at <http://www.gao.gov>.

¹¹Eurocontrol is Europe's organization for managing air traffic.

If you or your staff have any questions about this report, please contact me at (202) 512-3650. I can also be reached by E-mail at dillinghamg@gao.gov. Key contributors are listed in appendix I.

A handwritten signature in black ink that reads "Gerald L. Dillingham". The signature is fluid and cursive, with "Gerald L." on the first line and "Dillingham" on the second line.

Gerald L. Dillingham, Ph.D.
Director, Physical Infrastructure

Appendix I: GAO Contacts and Staff Acknowledgments

GAO Contacts

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Staff Acknowledgments

In addition to those individuals named above, Nabajyoti Barkakati, Geraldine C. Beard, Jeanine M. Brady, Peter G. Maristch, and Madhav S. Panwar made key contributions to this report.

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